Curriculum Evolution – University of Ferrara

The contribution of experience and genes on cognitive variability in teleost fish

A growing number of studies on different animal taxa have suggested that individuals have different cognitive abilities and achieve different problem solving performance. The causes of this variation are unknown so far and puzzling because directional selection is expected to favour individuals with greater cognitive abilities thereby reducing variability for this trait. The PhD candidate will use three teleost fish often adopted as models in evolutionary and behavioural research, the guppy *Poecilia reticulata*, the zebrafish *Danio rerio*, and the medaka *Oryzias latipes*, to address this problem in relation to two cognitive abilities that are critical for fitness: the ability to learn novel behaviours and the ability to inhibit behaviours that are not appropriate to a novel situation. He/she will use two experimental approaches: 1) evaluating the effect of experience on individuals' cognitive abilities via manipulation of environmental factors (social group, habitat complexity, food availability, and predation risk) during development in mesocosms; 2) estimating the effects of genes using an artificial selection approach to estimate hereditability of cognitive abilities. The project requires collaborating with experts from foreign institutions such as Liverpool John Moores University and Karlsruhe Institute of Technology.

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Curriculum Plant Biology and Biotechnology – University of Ferrara

Phenotyping of the photosynthetic apparatus in vascular plants

The candidate will focus on the study of the photosynthetic apparatus in vascular plants in the perspective of photosynthesis phenotyping. *Plant phenotyping* is achieving a more and more prominent role for the description of plant responses to environmental variations (light variations, drought stress, etc.), especially in crops and in plants species interesting for their phylogenetic position or environmental relevance. The candidate will apply biophysical, biochemical and ultrastructural methods to investigate meaningful relationships between synthetic parameters that describe the photosynthetic function (e.g. performance index, photochemical capacity) and properties of the photosynthetic membranes, such as thylakoid composition, supramolecular organization of complexes, electron flow, thylakoid architecture. The project can be completed through the access to the Slovak PlantScreen Phenotyping Unit in Nitra (Slovakia), belonging to the European Plant Phenotyping Network 2020 (EPPN2020).

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Curriculum Plant Biology and Biotechnology – University of Ferrara

The role and regulation of proline-P5C cycle in plants.

Proline-P5C interconversion in an apparently futile cycle has been hypothesized to play a role in the plant response to both pathogen attack and abiotic stress conditions. The candidate will study the properties and regulation of the enzymes involved in this cycle in both a model plant (arabidopsis) and a crop species (rice). Following the identification of specific inhibitors, these will be used to address a possible relationship between the cycle, the oxidation-reduction ratio of pyridine nucleotides and the induction of programmed cell death. Results will be compared with those attainable in a human system, where the proline-P5C cycle has been shown to take part in apoptosis, and seems a promising target for cancer therapy. With this aim, he/she will use techniques such as: heterologous expression of plant genes, biochemical and functional characterization of selected enzymes, measurement of transcription levels of selected genes, and metabolomic analyses (focusing mainly on amino acid and NAD(P)(H) content) in cell cultures and tissues of wild types plants and insertional mutants.

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Curriculum Ecology and Ethology – University of Firenze

Role of extracellular yeast vesicles as a miRNA carrier for the modulation of social insect behavior

Exosomes are small extracellular vesicles (EVs) that act as protein and RNA transporters capable of modulating cellular behavior. Yeast cells produce exosomes as a means of inter-cellular communication (from Silva RP et al., 2015; Rodrigues ML et al., 2011; Ludwig AK et al., 2011). Recently it has been observed that miRNAs of plant origin can be involved in interactions between plants and human immune system and plants and pollinators, particularly in caste differentiation (Schwander, T et al., 2010; Sagili, RR et al, 2018; Zhu, K. Et al 2017). Yeasts are associated to insects and have a great natural diversity. The idea of this project is to study the role of yeast and mushroom EVs, incuded S. cerevisiae, in conveying signals to the CNS, in insects like Apis mellifera. The transport of the vesicles will be monitored through chemoluminescence methods, in vivo imaging and Next generation sequencing, behavioral tests, learning and memory, caste differentiation, and the modulation of immune responses and inflammation.

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Curriculum Plant Biology and Biotechnology – University of Firenze

Relationship between ultrastructural data and transcription in stressed plant cells, with particular reference to autophagy and programmed cell death

The proposed investigation has the aim to compare the ultrastructural data obtained through observations with light and electron microscopy of plant organs, tissues and cells, subjected to several stress types or inducers of autophagy and programmed cell death. The so obtained morphological data, particularly in relation to the morphological features of the organelles, will be compared with data about RNA transcription, both with PCR of specific genes, and with NGS sequencing using the equipment available by the Department of Biology of the University of Florence. The last step will regard the bioinformatic analysis of data about RNA transcription to obtain conclusions about the link between the activation of specific genes and cellular morphology, referred particularly to autophagy and programmed cell death. The final aim will be the highlighting of which genes could be linked to specific ultrastructural morphologies.

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Curriculum Ecology and Ethology - University of Firenze

Spatial and temporal patterns in tropical forest mammal populations and communities from local to global scale.

Using a large dataset of standardized camera trapping data of mammals detected across the tropics (TEAM Network and Wildlife Insights), the candidate will perform analyses in hierarchical modeling framework, with the general objective of assessing variation in space and time of relevant state variables, such as occupancy and species / guild richness, from population and guilds, to community levels. Results will contribute addressing questions of methodological, ecological and conservation relevance, namely: (1) effects of climate, habitat and anthropic variables on the chosen state variables, for example on the functional trait composition of communities; (2) co-occurrence patterns (for example, predator and prey); (3) concordance between fine- and coarse-scale patterns.

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Curriculum Plant Biology and Biotechnology – University of Firenze

Merging spectral and phylogenetic diversity to assess macrophyte traits and functions along multiple gradients (macroDIVERSITY).

In the last decade, high-throughput techniques have been developed for the study of functional diversity of plant communities. Remote sensing spectroscopy has demonstrated great potential in assessing ecological processes, but linking spectral diversity and plant functional features is something that has yet to be established on a sound basis. Techniques based on genetics and phylogenetics have opened new ways of measuring biodiversity and delineating conservation priorities, but evidence on the role of phylogenetic diversity as a proxy of functional diversity or evolutionary potential at community level is still not decisive. A multidisciplinary approach joining these techniques could enable a step forward towards a better knowledge of ecosystem functioning and conservation of evolutionary potential. Our assumption, is that phylogenetics and imaging spectroscopy, properly calibrated and integrated, can be used to map plant traits and functions across scales and gradients with relatively low effort and high consistency. The macroDIVERSITY project proposes to merge spectral diversity to phylogenetic diversity metrics, in order to implement a feasible, quantitative approach to characterize macrophyte functional diversity and investigate its environmental drivers.

Within the framework of macroDIVERSITY, the candidate will deal with the phylogenetic reconstruction of macrophyte communities, and for the estimation of phylogenetic signals.

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Curriculum Evolution - University of Firenze

Reconstructing past human population history through a paleogenomic approach

The project will be focused on genomic analysis of ancient human remains for reconstructing the genetic history and the lifestyle of past populations. The candidate will be in charge of: i. applying molecular methods specifically developed to maximize the recovering of endogenous DNA from ancient human remains (bones, teeth, dental calculus); ii. preparing genomic libraries for NGS sequencing of ancient DNA; iii. managing target enrichment methods by hybridization capture; iv. performing quality control, quantification, and normalization of sequencing libraries. The candidate will also apply specific bioinformatic tools for the analysis of sequencing data (raw data processing, mapping, evaluation of degradation patterns, modern DNA contamination estimate, consensus sequence reconstruction and variant calling) and will perform explorative genetic analysis (mtDNA haplogroup assignment, PCA, admixture, molecular sex determination, metagenomics profiling of microbial communities).

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Curriculum Ecology and ethology – University of Firenze

Behavior and signals that mediate the host insect– ooparasitoid system

The project will analyze the complex system that mediates the interspecific relationships between hymenoptera ooparasitoids and their hosts. These systems, despite their considerable interest for biological control in agriculture and forestry, have not been fully investigated from an ethological perspective. Due to the accidental introduction of alien invasive phytophagous insects damaging some of the main agricultural crops, there is an increased interest in ooparasitoids able to limit populations of such pests. The project is aimed at studying the behavior of these oophagus in identifying and choosing the host, but also interspecific competition strategies. In a co-evolutive perspective, defense strategies of the target species will be addressed too.

The research will be realized combining observations and experiments in the laboratory and, partly, in a semi-field conditions and will involve different techniques to analyze signals and behaviors that mediate these interactions. The results will give useful information for developing new tools for pest control.

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Curriculum Ecology and Ethology – University of Firenze

Systematic camera trapping to study ecology and trends of mammal populations and communities: case study in Trentino as a model towards an Italian network of sites.

The student will join a long-term research and monitoring programme of mammals established in western Trentino in 2015 based on systematic camera trapping, and will engage into the following tasks: (1) continued field data collection and data management for the next 2-3 sampling years; (2) analyses of data in occupancy framework, aimed at assessing temporal trends in both community and population metrics; (3) focal analyses to address relevant ecological and conservation questions, namely the effects of anthropic presence and activities on target mammal species; (4) derivation of indices of management relevance (such as the Wildlife Picture Index); (5) contribute to the creation of a standardized framework for data-storing, management and analytics, functional to the replication of monitoring at additional sites.

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Curriculum Plant Biology and Biotechnology – University of Parma

Impacts of extreme climatic events on alpine ecosystems

Climate change is changing some key factors for plant life and biogeochemical cycles, including soil and air temperature and precipitation dynamics. Arctic and alpine tundra ecosystems are among the most affected by these changes. Research on the effects of global warming allows to make realistic predictions about the future dynamics of cold biome ecosystems and to generalize the responses of processes and functions, such as phenology, production, decomposition, composition of soil microbial communities and CO_2 fluxes. Less known are the effects of the decrease in soil water availability on alpine plant species and communities, despite the more recent climatic scenarios foresee a decrease in summer precipitation by the end of the 21st century. Current knowledge indicates that a reduction in precipitation will lead to a decrease in aboveground production, soil respiration and net CO_2 uptake. A further effect of climate change is the increase in the frequency and intensity of extreme climatic events, including heat waves which, following the event occurred in Europe in 2003, affected production, CO_2 fluxes and the different plant functional types. However, available data on the effects of reduced rainfall and heat waves is very scarce for alpine environments. The project will focus on the study of the effects of extreme climatic events on alpine primary grasslands (study site: Gavia Valley, Stelvio National Park, 2600 m a.s.l.). The investigation of activities and processes at different levels of biological organization (individual, species, community and ecosystem) will have to be directed towards increasing knowledge of the responses of alpine plants and communities to the expected climate changes, with particular focus on stress induced by heat waves and drought events. The possible integration of methods and approaches of plant biology and ecology with those of environmental microbiology will be positively evaluated.

The candidate should have great motivation for scientific research and ability to work both in the field (even in harsh conditions) and in the laboratory. Solid knowledge of applied statistics and alpine ecosystems will be considered as preferential requirements.

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Curriculum Ecology and Ethology - University of Parma

Application of machine learning techniques in ecology

The candidate will develop supervised learning algorithms for automatic image and pattern recognition in ecology. The development of image analysis systems (e.g. Machine Learning [ML], Artificial Neural Networks [ANN]) may enhance and support geometric morphometry methods for the identification of different species, from the mosquitoes (in particular sibling species of the *Anopheles* genus, potential vectors of Malaria), to butterflies and cetaceans. Such techniques may expand the potential for analyzing data on species distribution, passive acoustic monitoring (PAM) and survey, long-term experimental research, remote sensing and large-scale climate measurements. Global-scale environmental issues, from climate change to the spread of diseases and the availability of clean water, are creating pressure for ecologists to handle data and take advantage of scientific opportunities available through ML and ANN approaches.

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Curriculum Ecology and Ethology - University of Parma

Population structure of diadromous fish species determined by homing behaviour and environmental conditions

Native fish fauna of Italy is nowadays undergoing several threats and pressures. Among different species, diadromous fish are listed in the major IUCN risk categories and therefore deserve particular attention and strict action plans to promote their conservation, as also stated by International laws and regulations. With the aim of adding further knowledge on the biology and ecology of diadromous species, the PhD project will develop a multidisciplinary approach to assess the population structure of *Acipenser naccarii* (Adriatic sturgeon), *Anguilla anguilla* (European eel) and *Alosa fallax* (Twaite shad) in relation to their complex migratory strategies and reproductive biology.

The candidate will carry out a multidisciplinary approach based on molecular genetic tools plus such innovative techniques for fish monitoring as sonar-tracking, individual detection of tagged fish through antennas and floating receivers. The main project objective will be to evaluate the adaptive strategies evoluted by the three species, among which special attention will be dedicated to homing behavior in relation to seasonal variability of local environmental parameters. Investigations will be carried out in different water courses of the so called Padano-Veneto (continental bio-region) and Italico-Peninsulare (Mediterranean bio-region) districts. In fact, both districts are characterized by differences in climate, hydrographic, chemical, physical and biological parameters.

The project results will allow a better management of conservation issues applied to the three species. They will also contribute to long term data collection as prosecution of recently executed European projects for the improvement of environmental conditions of the investigated basins coupled to restocking of the fish species.

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Curriculum Ecology and Ethology - University of Parma

Merging spectral and eco-physiological diversity to assess macrophyte traits and functions along multiple gradients

Based on the assumption that imaging spectroscopy can be used to map plant traits and eco-physiological diversity across scales and gradients, the PhD project proposes a multidisciplinary approach joining multiple techniques for assessing macrophyte functional diversity, one of the biological components of freshwater systems most impacted at the global scale.

The candidate will collect data on macrophyte traits, eco-physiology, and spectral reflectance from stands sampled over selected lakes and wetlands in Italy and Europe (as control sites), according to a robust experimental design. Ultra-high resolution imaging spectroscopy data acquired over the plots will be used for mapping bio-chemical and functional macrophyte traits, including: canopy morphology, productivity, pigments and nutrients content. In situ support and verification activities (ground truthing) will allow to acquire information on the eco-physiological responses of the dominant species and of the macrophyte communities as the edaphic conditions change (including nutrient availability, trophic level of the colonized sites).Environmental parameters collected and diversity metrics derived will be eventually merged into a data-driven framework based machine learning for mapping macrophyte functional and eco-physiological diversity.

The project outcomes will benefit general and applied ecology studies and the sustainable conservation of aquatic ecosystems, as well as to counterbalance the apparent relentless loss of global biodiversity, especially for wetlands.

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Curriculum Ecology and Ethology – University of Parma

Census and assessment of sand and gravel pit lakes in the Po river basin: integrating satellite images with limnological studies

In the last fifty years, a great number of pit lakes have been formed by gravel and sand quarrying in heavily exploited river basins. After cessation of extraction activities, pit lakes can evolve into valuable aquatic ecosystems that can be managed for the ecological restoration of river margins, i.e. wetlands and biodiversity and related ecosystem services. However, despite their importance they are still understudied and inadequate management preclude the provision of key processes and services. River ecosystems and their lateral aquatic ecosystems respond rapidly to climate-induced and land use changes, often loosing biological components and functions. This project has two main aims: 1) to identify and map the pit lakes in the Po river basin and 2) to assess their hydro-morphology and water quality status in relation to local pressures and climate change. To achieve goal 1), satellite images with high spatial resolution (e.g. Sentinel-2, Rapid Eye) will be elaborated for realizing thematic maps on the location and evolution of the pit lakes and related aquatic ecosystems. To achieve goal 2) colour and transparency/turbidity of lake waters will be evaluated by satellite images. Changes in land use and riparian vegetation, as well as surface hydrology and climate data will also be analysed. Additionally, a sub-sample of pit lakes, representative of the different water colours and morphological conditions, will be sampled and water analysed for conventional chemical parameters. The accuracy of the methods applied will be then handled with appropriate statistical analysis. The satellite derived data along with on site limnological analysis will provide a scientific support for assessing how local pressures and climate changes are impacting on pit lakes, in order to promote a sustainable management of such aquatic ecosystems, e.g. for restoring ecosystem services previously provided by natural ecosystems which have disappeared.

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